REPORTS OF OBSERVATORIES.[1]

CHAMBERLIN OBSERVATORY, DENVER, COLORADO.

The work of the Chamberlin Observatory during 1906 was confined to observations of comets, the installation of some new apparatus, and some special studies in personal equation.

H. A. HOWE, *Director.*

INTERNATIONAL LATITUDE OBSERVATORY, UKIAH, CALIFORNIA.

The programme of the International Geodetic Association for observing variations of latitude was changed at the beginning of 1906 by dropping the twenty-four refraction pairs (pairs which culminate at large zenith-distances, about 60°), and also six of the latitude pairs, and substituting for these new latitude pairs. The observing-list now consists of ninety-six pairs, distributed throughout the twenty-four hours of right ascension, sixty-six of which belong to the old list and thirty of which are new. All of the stars culminate at zenith-distances of less than 26°.

Observations continued throughout 1906 without serious interruption from any cause. The weather was favorable during all months except February, March, and December, a monthly total of less than 150 pairs being considered unfavorable. The three longest intervals without observations were fourteen nights in August, eight nights in January, and six nights in each of February, November, and December. The first of these was caused by the absence of the observer and the others by unfavorable weather. The rainfall for the year was 51.8 inches. The maximum temperature was 108° F., on July 24th; the minimum temperature 22°, on November 24th, 28th, 29th.

The following table gives a summary of the observations made for the variation of latitude. The first column contains the number of determinations made each month, the second column the number of nights upon which observations were made, the third column the number of complete nights (sixteen determinations), the fourth column the greatest interval in each month during which no observations were obtained.

[1] Arranged alphabetically according to name.

1906.	Pairs.	Nights.	Nights.	Nights.
January	175	13	8	8
February	114	10	5	6
March	138	11	7	5
April	203	14	11	5
May	180	13	9	5
June	220	18	12	3
July	247	16	15	5
August	224	14	14	14
September	263	17	16	3
October	238	17	14	4
November	212	15	11	6
December	144	12	7	6
Totals	2,358	170	129	
Means	196.5	14	11	6

Definitive reductions of all the observations for the variation of latitude (233) obtained between April 4th and May 4th, both inclusive, were made in order to determine if possible whether or not there was an appreciable shift in the Earth's crust at Ukiah at the time of the earthquake of April 18th. No sudden change in the latitude was found. The results of the computations were printed in these *Publications* (vol. XVIII, p. 241).

SIDNEY D. TOWNLEY, *Astronomer-in-Charge.*

LICK OBSERVATORY, MT. HAMILTON, CALIFORNIA.

The scientific work of the Lick Observatory during the calendar year 1906 was pursued by each member of the staff with his accustomed industry and enthusiasm. It related for the most part to advancing the solution of the greater problems upon which we have been engaged in past years, and only here and there were minor or new problems taken up.

Professor TUCKER, with the aid of Mr. R. F. SANFORD, Carnegie Assistant, has completed the extensive reductions of his meridian-circle observations of 2,800 zodiacal stars, and the manuscript results are nearly ready for publication. The purpose of these observations is to provide more accurate reference-points in the zodiac as a basis for securing improved orbits of the planets.

Mr. TUCKER continued throughout the year the observation of a carefully constructed programme of stars, for the purpose

of securing a system of star places of the highest accuracy, which shall be strictly *fundamental,* as opposed to basing observations upon a system established with other instruments. There is need in these observations for the most accurate clock that can be secured, and a Rieffler constant-pressure clock, with nickel-steel pendulum, was installed late in 1906.

A special list of stars, used by Professor DOOLITTLE, of the University of Pennsylvania, in a study of terrestrial latitude variations, has also been observed by Mr. TUCKER.

Out of 965 photographs of the minor planet *Eros,* made at the favorable opposition of 1900, 525 have been selected as a basis for improving our knowledge of the Sun's distance from the Earth. Excellent progress in the measurement and reduction of these photographs has been made by Miss CHASE and Miss HOBE, Carnegie Assistants, under the supervision of Dr. PERRINE. Another year should see the work well along toward completion. There will be nothing of special interest to communicate to general readers until all the measures are combined in a final solution for the most probable value of the Sun's distance.

Good progress has been made in the study of the eclipse photographs of 1905, obtained by the Crocker Expeditions to Spain and Egypt.

Mr. PERRINE has made a careful examination of the photographs secured in Spain and Egypt for the intramercurial-planet search. The Spanish plates record stars in the region examined down to about the eighth photographic magnitude, but all of the images observed on the plates have been identified as those of well-known stars. Assuming that the planet would be one magnitude fainter photographically than visually, the search may be said to prove that no planet as bright as the seventh magnitude exists within the region searched. This includes an area about 9° by 29° lying along the direction of the Sun's equator.

It will be remembered that similar search made at the Sumatra eclipse of 1901 by Mr. PERRINE was limited in one third of the area to stars brighter than the sixth photographic magnitude. The Spanish results are thus an extension and advance of those secured in Sumatra. It is becoming more apparent that the anomalous motion of *Mercury's* perihelion must seek an explanation elsewhere than in the attractions of

intramercurial planets. A paper published very recently by Professor SEELIGER makes it extremely probable that the hitherto unexplained anomalies in the motions of the four inner planets are due to the attractions of the widely distributed materials responsible for the zodiacal light. It is unfortunate that clouds limited the observations in Sumatra and Spain. The cameras employed are capable of recording tenth-magnitude stars with clear skies and exposures of three minutes or less. It is hoped that an eclipse of the near future will enable this limit to be reached and thus give completeness to the observational programme.

The unusually favorable eclipse of 1905 afforded a hope that large-scale photographs of the corona secured in Labrador, Spain, and Egypt, or in two of these countries, would enable us to detect changes in the coronal structure occurring between the instants of totality in those countries. Dr. PERRINE and I have made careful comparisons of the photographs secured in Spain and Egypt. A number of well-defined nuclei existed both east and west of the Sun. Details of structure within the nuclei suffered change, but the masses as a whole appeared to remain in fixed positions. We are able to say that those masses could not have moved so much as one mile per second during the interval of seventy minutes which elapsed between the totalities in Spain and Egypt. Greater speeds might well have occurred in the principal coronal streamers without our having detected them; for their structure is uniform and regular, and well-defined nuclei are absent. Thus, in the cases where high speeds should perhaps be most expected, the photographic method has little power to detect them.

In connection with the Sumatra eclipse, Mr. PERRINE was able to reach the interesting conclusion that a large disturbed volume of the corona, conical in form, appeared to be situated exactly over the large and only sun-spot visible during several days preceding and following the eclipse. A very similar disturbed volume is shown on the coronal photographs of 1905. The vertex of the cone does not appear to be over one of the large spots then existing on the Sun, but it is above a large region of the photosphere which shows many signs of disturbance.

The complete reduction of the time and longitude observations in Spain confirms definitely the conclusion reached on

eclipse day,—that mid-totality occurred twenty seconds earlier than the time predicted by the nautical almanacs.

It is hoped that the spectrographic and polarigraphic results will be ready for publication within the coming year.

The D. O. Mills Expedition to Chile terminated its first period of activity on March 1, 1906. At that time Dr. CURTIS assumed charge for the second period of five years, in succession to Professor WRIGHT, who returned to California shortly thereafter. The working programme of the original expedition called for spectrograms of all the brighter stars south of declination $-25°$ which should contain lines capable of accurate measurement, down to photographic magnitude 5.5. The stars so selected formed a list of 143. Four spectrograms were obtained of practically every star on the list, and additional ones of many others were taken for special purposes. Eight hundred spectrograms in all were obtained. The half of these were definitively measured and reduced by January, 1907, and it is expected that the results from the other plates will be ready by the middle of the present calendar year.

I am inclined to ascribe great importance to this programme of work, now nearing completion in accordance with plans which have been definitely held in mind since 1894. There is a tremendous demand for the knowledge of the velocities of the stars determined spectrographically, for use (*a*) in determining the motion of the solar system as a whole, and (*b*) in determining the structure of the sidereal universe. Observations of this kind either have been made or are under way at ten northern-hemisphere observatories. The southern two sevenths of the sky, out of reach of northern instruments, must be observed in the same manner before a satisfactory solution of these problems can be hoped for, and before the observations of the northern stars can assume their full value. Up to 1906 existing southern-hemisphere observatories have published spectrographic velocities of but two or three stars. The Mills Expedition was organized to secure observations of the brighter stars with special reference to their use in problem *a*.

In the erection of the observatory on Cerro San Cristobal, Santiago, during the rainy season, in meeting and overcoming difficulties as they arose, and in carrying out the programme of observation as planned within the estimated time, Acting-

Astronomer WILLIAM H. WRIGHT, in charge of the expedition, is entitled to great credit.

The dearth of southern-hemisphere observations of the exact kinds that the Mills Observatory is fitted to supply made it extremely desirable that our station should continue in active existence. When the subject was presented to Mr. MILLS, he was pleased to provide for its liberal support through a further period of five years, and for many improvements and additions to the instrumental equipment. Dr. CURTIS, in charge of the expedition during its second term, is assisted by Mr. GEORGE PADDOCK, formerly of the University of Virginia.

The determinations of the radial velocities of the stars on Mt. Hamilton by means of the Mills spectrograph attached to the 36-inch equatorial made good progress during the year 1906. About 400 spectrograms were secured, principally by Messrs. CAMPBELL, MOORE, and WRIGHT. The stars observed were, on the average, fainter than in former years. This involved longer exposures, and resulted in a slightly reduced number. A considerably larger number of spectrograms taken in 1906 and former years were measured and reduced definitively, principally by Messrs. MOORE, BURNS, and NEWKIRK.

Professor AITKEN'S programme of double-star observations with the 12-inch and 36-inch refractors has two main purposes: (*a*) to examine systematically all the stars to the ninth magnitude inclusive between the North Pole and $-22°$ of declination, checking the positions of all previously known double stars and noting all additional pairs that are under five seconds in distance, as the basis for a thorough statistical study of double stars; and (*b*) to measure regularly all known double stars showing motions of revolution, especially the more rapid and difficult pairs, to provide data for improving our knowledge of their orbits.

Approximately, 300 new pairs were discovered in the year. Seventy-five per cent of them are under two seconds of arc. This work involved careful examination of 10,000 stars, in round numbers. The total number of new stars discovered by Messrs. AITKEN and HUSSEY, who co-operated in organizing and prosecuting this double-star survey, is about 2,900. Given reasonably good winter skies, the programme for the northern hemisphere should be completed by Dr. AITKEN within three years.

The second part of Dr. AITKEN'S programme is thoroughly systematized, so that observations of the more rapid and difficult pairs are obtained at the times most advantageous for determining their orbits.

A considerable number of micrometer observations of the comets of 1906 have been made by Messrs. AITKEN, MADDRILL, SMITH, and FATH.

A large number of photographs of *Jupiter's* sixth and seventh satellites have been obtained by Dr. PERRINE with the Crossley reflector for the purpose of improving our knowledge of their orbits. Photographs of *Saturn's* ninth satellite and *Neptune's* satellite have also been secured. Extensive experimental work with reference to future investigations with this instrument have also been conducted by Dr. PERRINE.

Very extensive observations of several well-known variable stars have been made with the one-prism spectrograph by Messrs. ALBRECHT and MADDRILL, as a basis for theses, in partial fulfillment of requirements for the degree of Doctor of Philosophy. In all cases these variables have been shown to be spectroscopic binaries, and their accurate observations will be of great value in the efforts that are constantly being made to determine why these and other stars of their class vary in brightness.

Mr. MADDRILL has given special attention also to the photometry of several variable stars with a view to determining possible relationships between peculiarities in their brightness- and velocity-curves. His photometric results are of very satisfactory accuracy.

A fruitful investigation has been made by Dr. ALBRECHT on the relation of the effective wave-lengths of blended spectral lines and stellar spectra of different types. He has shown that the effective wave-lengths of many blends change progressively with the spectral type.

A long list of minor investigations and results should for completeness be mentioned, but space is lacking.

The observatory has abundant cause for thanksgiving in that the great earthquake of April 18th did very little damage. Reference may be made to an article on this subject in an earlier number of these *Publications*. The D. O. Mills Observatory, Chile, had its corresponding experience only four months later, and was equally fortunate. Let us hope that

these trials, so closely connected in time and giving rise to so much anxiety, were but a horrible coincidence, and that they may not recur for many generations.

The installation of an important electric plant for lighting and power purposes began in May, under the difficult conditions of supply, labor, and finance induced by the earthquake and fire. It should be completed early in the year 1907. An automatic pumping plant, installed at the same time, is in operation, and promises to increase the water supply three- or fourfold, with little expense.

Acknowledgments are due to the Regents of the University of California, to Mr. D. O. MILLS, to Mr. W. H. CROCKER, and to the Carnegie Institution for generous financial support, and to all the members of the Observatory Staff for their enthusiastic and efficient aid in carrying out the scientific plans.

W. W. CAMPBELL, *Director.*

LOWELL OBSERVATORY, FLAGSTAFF, ARIZONA.

During the first part of the year the large telescope was employed in spectrographic work, the charting of star-fields with the Brashear photographic doublet and micrometric observations. Since July the doublet has been mounted on the 6-inch Clark refractor, and the time of the large telescope has been devoted, for the greater part, to spectrographic observations. During the summer and autumn further experiments in planetary photography were carried on.

Mr. SLIPHER'S programme of spectrographic work has consisted principally of line-of-sight observations of stars. Modification of parts of the large three-prism spectrograph were made by BRASHEAR in January, February, and March. The changes made, remounting of the prisms and providing the collimator with a curved slit, have proved very satisfactory, and have added much to the efficiency of the instrument. Observations were made with the three-prism spectrograph until the middle of August. During the autumn months spectrographic observations of the fainter stars were made with the single-prism spectrograph. The original mounting for the simple prism which made use of the spectrometer section of the large spectrograph, lacked stability for long exposures. But after modification of this part, from designs by Mr.

SLIPHER, no trace of flexure has been found for exposure of as much as four hours' duration on the one side of the meridian. In the single-prism instrument one of the dense flint prisms of the prism-train of the large spectrograph has been used. This prism gives a dispersion of 35 tenth-meters per millimeter at Hγ. By tipping the plate the camera is made to give a sharp focus over the range of spectrum comprised between K and λ 4600, over which region the measures are commonly extended. In the course of this work several stars have been found to have variable radial velocity, and the spectrum of ε *Capricorni* has been found to contain bright lines. Though the measurement of the plates is much in arrears, the results thus far obtained indicate a large field of work for this form of instrument. Of the spectra of variable stars photographed with the single-prism instrument the most interesting is perhaps that of *Mira Ceti,* secured at the recent unusually bright maximum of this star during December and January. One spectrogram was made with the three-prism instrument. With the improved sensitizing dyes now available, giving a fairly even deposit over the entire range of sensitiveness of the plate, it was possible to photograph the spectrum with the single-prism instrument from below B to Hδ. All the hydrogen lines covered by the plate are bright. (See note in the *Astrophysical Journal* for January, 1907, and the reproduction of one of the plates of the spectrum in the March number of that publication.) In connection with the spectrographic work, Mr. SLIPHER has experimented further with sensitizing dyes, particularly those active for the less refrangible end of the spectrum, for the application of such to photographic investigation of absorption bands in planetary spectra and also for work on the lower end of stellar spectra, with the result that plates more sensitive to the red can now be prepared. The greater rapidity and more perfect gradation of these plates than of those formerly available makes it possible to extend the study of the spectra of planets and stars considerably farther into the red.

A great many star-fields have been photographed with the Brashear doublet during the year. This lens was at first carried on the 24-inch refractor. When the mounting of the 6-inch Clark refractor was completed, in July, the doublet was mounted on it, and since then the time of this instrument has been devoted wholly to photography. This work was done

until June by Mr. J. C. DUNCAN, Lawrence Fellow at this observatory for 1905-1906. Since July the work has been continued by Mr. E. C. SLIPHER, fellow for the present year.

In addition to making photographs of star-fields and the series of photographs of Comet *c* 1905, Mr. DUNCAN made micrometric measures for position of Comets *c* 1905, *a* and *b* 1906.

In view of the approaching favorable opposition of *Mars,* further experiments in planetary photography have been carried on by Mr. LAMPLAND. It is hoped that the greater brightness and larger disk of the planet, together with such improvement as may be expected from past experience and more suitable and efficient apparatus, will bring still better results than were obtained in 1905. For the present, at least, the greatest value of the results obtained by photography is the evidence the negative brings to corroborate data obtained visually. The great mass of observational data and the results deduced therefrom, accumulated since SCHIAPARELLI'S epoch-making observations were begun, have been obscured and distorted more or less by unfounded skepticism, based on the idea that many of the observed phenomena are subjective effects or spurious products of observation. The questions raised have been thoroughly investigated from the standpoint of theory and experiment and found untenable. With the further confirmation of the visual results by photography, it seems that there should be no room for doubt in the matter.

PERCIVAL LOWELL.

NAVAL OBSERVATORY, MARE ISLAND, CALIFORNIA.

As indicated in the last annual report, this observatory was established mainly for keeping up the public time service for the Pacific Coast, and for the rating of chronometers used in the naval service. During the past year the work has been maintained as usual.

At the time of the great earthquake the time-signals were sent out the following day, but the Western Union Telegraph Company's lines were so deranged and congested with business that the signals could not always be delivered. Yet even during this trying period they managed to deliver the signals about every second day, which was sufficient for commercial purposes. The earthquake stopped two of the four clocks of

the observatory, and deranged the time of the other two by more than twenty seconds. The pendulums rubbed against the index ledges, and this with the shocks affected the rates of motion.

The earthquake was carefully observed here, and a full report has been submitted to the State Earthquake Commission. After this terrible disaster to the State, the theory of earthquakes ordinarily adopted seemed so improbable and so incapable of explaining the observed phenomena that a general survey of the subject was attempted, in the hope of gaining a better understanding of the cause of such disturbances. The results of this investigation have just been published in the *Proceedings* of the American Philosophical Society at Philadelphia. It is shown that the main cause of great earthquakes is the expulsion of lava from under the bed of the sea, by the explosive power of steam, which forms beneath the Earth's crust, owing to the secular leakage of the ocean bottoms. Another investigation is about finished which deals with the problem of the secular cooling of the Earth and the theory of contraction, so generally adopted in the physical sciences. The results obtained are not without interest to investigators.

A new Riefler clock, moving in an air-tight case, has just been installed in the observatory, and it promises to perform with great perfection, and will thus afford additional accuracy to the time service in the winter season, when long spells of cloudy weather are common.

T. J. J. See,
Professor of Mathematics, U. S. N.,
in charge of the Observatory.

SOLAR OBSERVATORY OF THE CARNEGIE INSTITUTION OF WASHINGTON, MT. WILSON, CALIFORNIA.

The most important event of the year, so far as its bearing on the future of the observatory is concerned, was the gift of $45,000 by Mr. John D. Hooker, to meet the cost of a mirror of one hundred inches aperture for a great reflecting telescope. The difficulties in the way of constructing and using successfully a mirror of this size have been outlined elsewhere. It is sufficient to say here that the mirror is certain to give results of great importance in those classes of work where the finest definition is not essential, while there is good reason to hope

that for the direct photography of nebulæ, and for other investigations requiring even more perfect definition, there will be some nights in the year in which the full advantages of the large aperture will be realized. The glass disk has been ordered from the plate-glass works at St. Gobain, France, and work has been undertaken on the fireproof structure in which the grinding and polishing of the mirror will be done by Professor RITCHEY.

The work of research has included:

1. Daily photography of the Sun with the photoheliograph;
2. Daily photography of the Sun with the spectroheliograph;
3. Photography of the spectra of sun-spots;
4. Photography of the flocculi, for the determination of the radial velocity of the calcium vapor;
5. Spectrographic investigations of the solar rotation;
6. Bolographic investigations of the solar absorption;
7. Special studies of stellar spectra with a spectrograph of high dispersion;
8. Laboratory investigations;
9. Preliminary studies of the correlation of solar and magnetic phenomena.

The 5-foot spectroheliograph was erected in the Snow telescope-house in October, 1905. It has given admirable results from the outset, the daily records including photographs of the Sun with the calcium, hydrogen, and iron lines. These photographs have been studied in various ways, the principal routine investigation in which they are employed being a determination of the solar rotation. The daily motions of the calcium flocculi required for this purpose are measured by Miss WARE, with the "heliomicrometer," an instrument which permits the latitude and longitude of points on a photograph of the Sun to be measured directly, without computation. This instrument was constructed in the observatory shop and has been thoroughly tested during the year. Measures can be made with it as rapidly as with ordinary measuring-machines, and apparently with no less precision.

A comparative study of the hydrogen and calcium flocculi indicates that the former lie at a somewhat higher level in the solar atmosphere. Stereoscopic comparisons of calcium photo-

graphs taken at intervals ranging from one to ten hours have also proved very instructive.

Much time has been devoted to the study of the spectra of sun-spots, for the purpose of interpreting the cause of the strengthening and weakening of solar lines. The photographs of spot spectra used for this work were taken by Mr. ADAMS and Mr. ELLERMAN with the 18-foot Littrow spectrograph, used in conjunction with the Snow telescope. These photographs show thousands of lines not previously recorded, and have served admirably for present investigations. For the interpretation of the changes in the relative intensities of the lines, many laboratory experiments were made by Dr. GALE. It was soon found that by varying the temperature of a metallic vapor, such as iron or titanium, the changes in the relative intensities of the lines observed in sun-spots could be closely imitated. This work, carried out systematically, led to the conclusion that the characteristic line intensities of spot spectra are probably the result of the reduced temperature of the spot vapors, as compared with those of the ordinary reversing layer. This conclusion was confirmed by the discovery in spot spectra of the flutings of titanium, which do not appear to be present at the higher temperature of regions outside of spots.

A study of the spectrum of *Arcturus,* photographed with a spectrograph of very high dispersion, showed that the lines that are strengthened in sun-spots are in general strengthened in this star, at least in the region investigated. Lines that are weakened in sun-spots also appear to be weakened in *Arcturus*. This is a natural result if we assume a spot to be a comparatively cool region on the Sun, and if we suppose *Arcturus* to be a star like the Sun, cooled to a temperature of the same order as that of sun-spots. The presence of titanium flutings in third-type stars affords another close bond of connection between these stars and sun-spots. Results of this character, when followed up with the aid of the 60-inch reflector, should throw much light on the temperature classification of stars.

The radial motion of the calcium vapor in the flocculi has been studied spectrographically by Mr. ADAMS. The average displacement of the H_3 and K_3 lines corresponds to a velocity of approach of the calcium vapor amounting to about 0.41^{km} per second. The varying displacements obtained at different times, however, indicate that general conclusions should be

based only on very extensive investigations. The results given by the bright lines H_2 and K_2 also show a displacement toward the violet, so that the calcium vapor in the flocculi may be regarded as moving upward.

Mr. ADAMS is engaged on an extensive study of the solar rotation, based upon comparative photographs of the spectra of opposite limbs, made with the 18-foot spectrograph of the Snow telescope. The results, so far as reduced, are very consistent, and should prove to be an important contribution to this subject.

Bolographic studies of the absorption of the solar atmosphere, made by Dr. PALMER, with the advice and co-operation of Mr. ABBOT, seem to indicate that the absorption may fluctuate in an irregular manner within short periods. No satisfactory conclusions can be drawn, however, until the investigation has been carried farther and correlated with simultaneous studies of the solar constant.

Professor E. F. NICHOLS, of Columbia University, carried on two special investigations during the summer. One of these was the study of the effect of the ionization produced by X-rays upon the absorption or radiation of a gas or vapor. The second investigation dealt with the question whether the "Reststrahlen" obtained after repeated reflections from rock-salt surfaces reach us in any appreciable amount from the Sun.

The latitude and longitude of the Solar Observatory were determined by Messrs. SMITH and MCGRATH, of the U. S. Coast Survey. The results obtained are as follows:—

	Mt. Wilson Triangulation Station.	Snow Telescope Pier.
Latitude	34° 12′ 59″.72	34° 12′ 59″.53
Longitude	118 3 45 .54	118 3 34 .89

The Smithsonian Institution sent a second expedition to Mt. Wilson during the summer of 1906, for the purpose of continuing the work undertaken in 1905. Although the season was hardly as satisfactory as the previous one, a large number of determinations of the solar constant were obtained. These are of a high order of precision, and should leave no doubt, when reduced, of the character of the variations which the results of 1905 seemed to exhibit. The admirable methods developed by Mr. ABBOT, in conjunction with the late Secretary LANGLEY,

seem well calculated to clear up the long-standing question as to the variability of the solar radiation.

The work of the Computing Division has been organized and placed under the direction of Mr. ADAMS. A series of offices added to our building in Pasadena provide suitable quarters for this work. Three computers, Miss WARE, Miss LASBY, and Miss SMITH, are at present employed. Miss WARE, as already stated, is engaged in the measurement of solar photographs with the "heliomicrometer." Miss LASBY is measuring Mr. ADAMS'S photographs of spectra taken for the determination of the solar rotation. Miss SMITH is measuring the area of the calcium flocculi, in regions ten degrees square on the solar surface, for the purpose of ascertaining the distribution and variation of the solar activity. Special apparatus, devised for this purpose, was constructed in the observatory instrument-shop.

The work of the Construction Division has made admirable progress under the direction of Professor RITCHEY. Work has advanced on the 60-inch mirror and its mounting, the heavy parts of which were received from the Union Iron Works in the autumn. In addition, many smaller instruments have been constructed. The five-ton automobile truck, to be used for transporting the mounting of the large reflector and the steel for the building and dome in which it is to stand to the summit of the mountain, has also arrived in Pasadena. The work of widening the "New Trail" into a road is well advanced and will be completed in the spring. This work has been carried out under the immediate superintendence of Mr. GODFREY SYKES, of the Desert Botanical Laboratory of the Carnegie Institution, acting under the general direction and with the active co-operation of Professor RITCHEY.

Further details of the work of the year may be found in the Annual Report of the Director, in Year Book No. 5 of the Carnegie Institution, and in *Contributions from the Solar Observatory,* Nos. 3 to 14.

GEORGE E. HALE, *Director.*

STUDENTS' OBSERVATORY, BERKELEY ASTRONOMICAL DEPARTMENT, UNIVERSITY OF CALIFORNIA.

The year ending December last has been notable for a marked increase in enrollment in the courses offered by the Berkeley Astronomical Department. The number of students

during the fall term of the year 1906 was 216, the same as the combined enrollment for the two preceding terms. With the enrollment during the current term, the attendance for the academic year (1906-1907) has reached 378, as against 216 for the preceding year.

The staff of the department has devoted practically all of its time to instruction and has had to forego the much-desired completion of several astronomical investigations. The department was further seriously handicapped during the fall term by a prolonged illness of Mr. EINARSON, the assistant.

Nevertheless, the regular computation by the "Short Method" of one or more preliminary orbits of all newly discovered comets was continued during the year, with the exception of one case, by Dr. CRAWFORD, generally with the assistance of graduate students.

In his capacity as member and secretary of the State Earthquake Investigation Commission, the Director has devoted much time to the collection and systematizing of data on the California earthquake of April 18th.

On July 1, 1906, Dr. CRAWFORD was promoted to be Assistant Professor of Practical Astronomy.

Important additions to the instrumental equipment have not been made. The observatory has been fortunate, however, in having the use of an Omori tronometer belonging to the Imperial Earthquake Investigation Commission of Japan. With the aid of this instrument numerous good records of after-shocks have been secured, as well as records of three earthquakes at a distance, including the Valparaiso earthquake in August.

The work on the Watson asteroids has progressed sufficiently to make it certain that the tables of twelve asteroids reported on a year ago will go to press in April.

The chief assistant in this work has been Miss ESTELLE GLANCY, Dr. NEWKIRK having accepted a position as Carnegie Research Assistant at the Lick Observatory in September.

Dr. CRAWFORD'S further investigation of the constant of refraction, and Dr. NEWKIRK'S tables for the reduction of measured photographic positions and his investigation of the Repsold measuring-engine are to be published in April.

A. O. LEUSCHNER, *Director.*